Abstract for an Invited Paper
for the 1995 Topical Conference
on Shock Waves in Condensed Matter
American Physical Society

Seattle, WA, 13 August–18 August 1995

Shock Temperature Measurements of Liquid Hydrogen [*]

N. C. Holmes[†], *Lawrence Livermore National Laboratory*

We measured the temperature of singly- and double-shocked liquid deuterium and hydrogen, reaching temperatures as high as 5200 K at 87 GPa. The temperatures were determined using a fiber-optic pyrometric method,[‡] in which the time-resolved emission from the luminous shock front is fit to a grey-body spectrum. The results for all of the first shock experiments agree well with the predictions of previously published theory.[§] The double-shock temperatures, however, are as much as 40% lower than predicted by that theory. The lower temperatures are a result of a fraction of the available shock energy being used to dissociate some of the hydrogen molecules. A new model has been developed for which the molecular dissociation energy decreases with volume. Double-shock experiments, which reach higher densities than equivalent-pressure experiments on the Hugoniot, are sensitive tests of such a hypothesis. In fact, such a model is needed to determine the final double-shock pressure and volume. The overall agreement with experiment is now excellent. We will describe the experiments in detail, followed by an exposition of the present theoretical model. Implications for high-energy density molecular hydrogen systems will be discussed.

[†]performed in collaboration with W. J. Nellis and M. Ross
[*]Work performed under the auspices of the U.S. DOE by the LLNL under contract No. W–7405–ENG–48.
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